

Renewable Energy Laboratory

The global Renewable Energy sector has been growing at a rapid pace over the past few years. Amid climate change concern and desires for energy security, favorable policy supports has been witnessed from the government, coupled with rising cost competitiveness on technology advances. The Renewable Industry in India is growing exponentially. The Government is striving hard to push the solar power industry to make India a global leader by introducing grid based incentives and concessions. Indian Renewable Energy Mission targets total installation of 175 GW of Renewable Energy by 2022, giving vast opportunity for exploitation of solar as energy source.

Why Renewable Energy Training

Solar and Wind as an energy source also has massive employments opportunities for all segments. The Indian Renewable market is on a high-growth curve and an estimated 10 lakh professionally qualified individuals in solar and wind industry will be required in the coming year. This scenario also leads to the challenge of development of human resource. With companies and governments pouring funds in to the solar and wind industry in India, relatively few people are qualified to implement solar on such a grand scale. In order to realize the full potential of solar energy in India, there is an immediate need to create a qualified workforce not just at the engineers and managers level but also at the grass root level of technicians and operators.

Keeping in mind the changing dynamics of solar industry in India, ECOSENSE Sustainable Solutions with expert guidance from IIT Delhi and IIT Bombay has developed a **Renewable Energy Lab** focused directly to the need of training of engineers in the solar industry. This **Renewable Energy Lab** will help the participants in training programs to learn the basics of Solar Power and also can understand how to install, operate and maintain.

The future demand for Renewable Energy professionals in the Indian as well as global market is expected to be huge. It makes sense for students to be trained on practical aspects of Solar and Wind Energy systems.

RE Laboratory has the following equipments:

- Solar PV Training and Research System
- Solar PV Grid Tied Training System
- Solar PV Emulator
- Wind Energy Training System

Stand alone system

- Battery charging and discharging characteristics.
- Demo of system using DC load with battery, (with variable rated capacity of system).
- Demo of system using AC load with battery.
- Combine AC and DC load system with battery.



Maximum Power Point Tracking

- Finding MPP by varying the resistive load across the PV panel.
- Finding MPP by varying the duty cycle of DC-DC converter.
- Using MPPT algorithm find the V_{mx} , I_{mx} and P_{max} and duty cycle at which MPP occurs.
- Perform the experiment (3) with Solar PV Grid-Tied Training System

A Solar Grid-tied System is a grid connected PV system which links solar power generated by the PV modules to the mains. It acts as an interactive medium where the demand for electricity is fulfilled by the conglomeration of PV and mains. This product gives a deep insight into the dynamics of a Grid Tied system, its operation and maintenance.

2.1 Technical Specifications

Sl. No.	Components	Sub-Components	Specifications
1	Power generating unit	Solar PV Module	
		Number of modules	2
		Type	Poly-crystalline
		Total power	500 W _p
2	Solar PV Grid Tied Inverter		
		No of Grid Tied Inverter	1
		MPP voltage range	45 V to 100 V
		Rated grid voltage	230 V
		Maximum output current	2.5 A
		Rated power	300 W
		Rated frequency	50 Hz
		Feeding phases	single-phase
3	Virtual Grid		
		Nominal Output Voltage	230V AC
		Frequency	50Hz
		Capacitor Bank	
		Transmission Line Inductance	
4	Measurement Unit	Isolated Sensors	
		AC Voltage Sensor	
		AC Current Sensor	
		Power Analyzers – 2	
		Ammeter –AC	
5	Accessories	Manual	

2.2 Salient Features

- Virtual Grid
- Automatic Solar Power Priority
- Active, reactive and apparent power flow tracking
- Net Metering indicating net import/export of energy from/to grid
- Anti-Islanding protection
- Variable Line inductance, capacitance of grid

2.3 List of Experiments

1. Observation of Current Waveform for Linear & Nonlinear Loads and Calculations
2. Impact of Transmission Line Inductance on Voltage Quality at PCC
3. Power Factor Correction using Capacitor Bank and its Impact on Power Quality at PCC
4. Grid Synchronization of Solar PV Inverter and its Performance Analysis
5. Evaluation of Active, Reactive & Apparent Power Flow between Grid-Tied Inverter, Grid & Load with Net Metering concept
6. Demonstration of Anti-Islanding protection of Grid-Tied Inverter for Sudden Grid Failure and running the system using virtual grid



1. Wind Energy Training System

Wind Energy Training System is a miniature replica of actual wind turbine power plant. This system facilitates the students with working and configurable model of wind turbine. This system gives the insight about individual components and consequences of changing the operating points of any wind turbine defined in terms of wind speed and pitch angle. Students can learn concepts like I-V characteristic, cut-off, cut-in speed etc.

4.1 Technical Specifications

Sl. No.	Components	Sub-Components	Specifications
1	Generating unit	Generator	
		Type	PMSG (3 phase)
		Power rating	300 (W)
		Rotor	
		No. of blades	3

		Swept area	1.4 (m^2)
		Performance parameter	
		Rated wind speed	12.5 ($\frac{m}{sec}$)
		Power generation at rated speed	300(W)
		Cut-in speed	3.5 ($\frac{m}{sec}$)
		Cut-out speed	23 ($\frac{m}{sec}$)
		Blade	
		Length:	0.67 (m)
		Material	Carbon fiber
2	Artificial Wind generating unit	Induction motor	
		Power rating	15 (HP)
		Generated wind speed range	0-15 m/sec
3	Control Unit	Battery	
		Capacity	42 (Ah)/12V
		Inverter	
		Rated power	650(VA)
		Input voltage	10-15(V)
		Charge controller	
		Rated power	400(W)
		Rated load voltage	12 (V)
		DC voltmeters/ammeter	
		AC voltmeters/ammeter	
		Power analyzers	
		Current rating	18 A
		Tachometer with sensor	
		Anemometer	
4	Accessories	Manual	

4.2 Salient Features

- Wind speed can be controlled externally
- Turbine can be replaced
- System can be expanded to develop a hybrid system
- Performance can be evaluated from low wind speed to high wind speed

4.3 List of Experiments

- Evaluation of charge controller efficiency
- Evaluation of cut-in speed of wind turbine
- Evaluation of Tip Speed Ratio (TSR) at different wind speeds



SOLAR PV GRID TIED SYSTEM



WIND ENERGY SYSTEM

DC Microgrid Energy Management System- Rs.12,09,500/-

- ✿ **DC microgrid energy management system**
- ✿ 5 kW System with Multi-output Current and Voltage control Schemes
- ✿ Bi-directional and dual control approach (Voltage/Current)
- ✿ Input/ Output Voltage, Current and power measurement display units
- ✿ Seamless control through NI-LabVIEW software
- ✿ Current Control with 0.1 A Accuracy, Voltage Control with 0.1 V Accuracy
- ✿ Provided with Over current, Over voltage, Over Power Protection
- ✿ Provided with memory storage function
- ✿ On board Voltage, current sensors and complete digital display
- ✿ Provided with inherent CC and CV mode for seam less control
- ✿ Complete system can be controlled through either wirelessly or USB mode
- **Lithium-ion Batteries 0.5 kWh**
 - ✿ 12 V 40 Ah with charge controller protection board
- **1000W Grid tie inverter 220v, 230v, 240VAC for 30V/36V Panel with MPPT functions, solar power inverter**
 - ✿ Generates pure Sine Wave
 - ✿ Automatic power adjustment
 - ✿ Constant Power Output
 - ✿ Low distortion output on all ranges
 - ✿ Allow different Power factor from load
 - ✿ Compact and light weight design
 - ✿ Maximum Power Point Tracking (MPPT) - optimize power output
 - ✿ Plug and Play Design, simply plug into an outlet (GFI), no hard-wiring
 - ✿ Stackable (connect in parallel for higher output)
 - ✿ Aluminum enclosure will act as heat sink to help dissipate heat
 - ✿ Simple and safe installation
 - ✿ Island protection: Inverter will shut down during black outs.
- ✿ **PV Emulator**
50V 20 A solar photovoltaic emulator characteristics
 - ✿ Able to emulate for various irradiation condition
 - ✿ Complete user control parameters as per two diode model
 - ✿ Current Control with 0.1 A Accuracy, Voltage Control with 0.1 V Accuracy
 - ✿ Provided with Over current, Over voltage, Over Power Protection
 - ✿ Provided with memory storage function
 - ✿ On board Voltage, current sensors and complete digital display
 - ✿ Complete system can be controlled through either wirelessly or USB mode



- **AC110V/AC220V To DC 48V 20A 1000W Switch Power Supply for DC grid and Emulator**
 - ✿ Input Voltage: AC110V/AC220V \pm 15%
 - ✿ Output Voltage: 48V DC
 - ✿ Wattage: 1000W
 - ✿ Shell Material: Metal case / Aluminum base
 - ✿ Protection: Shortage Protection, Overload Protection, Over Voltage Protection
 - ✿ Widely used in Industrial automation, LED display, communications, etc.
 - ✿ Safety Compliance: CCC/ FCC / CE
 - ✿ Working Temperature: 0~40°C
 - ✿ Storage Temperature: -20~60°C
 - ✿ Ambient Humidity: 0~95% non-Condensation
- **Voltage, Current, Power Frequency, Power factor, Energy, having RS485 Modbus Electronic Module with Coil CT&USB Cable**

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